ANTI-LACERATION GLAZING

The invention belongs to the area of glazing and, in particular, relates to the protection of individuals who happen to be close to glazing when same is shattered.

In the case of the automobile, considerable efforts have been made to date to adapt the structure of glazings and the nature of their component materials from a point of view of protection of the occupants. For this purpose, various types of accidents likely to occur formed the subject of simulations.

One of the problems which could be clearly identified relates to tempered monolithic glazings, widely used as side glazings, in particular vertically movable. In the event of impact due to a collision, a rollover, etc., this type of glazing shatters into a thousand fragments, completely clearing the window opening. It has been learned that the ejection of the occupants through this opening constitutes one of the most critical risks because of its frequency and the severity of its consequences, in particular the crushing of the occupant by the body of the vehicle.

With a concern for improving safety conditions, one of the means consisted in replacing the tempered monolithic glazings, with thicknesses generally at least equal to 3 mm, with laminated glazings composed of two sheets of glass more or less tempered or merely annealed, with thicknesses ranging between approximately 1 and 3 mm, sandwiching an intercalary adhesive, generally a layer of polyvinylbutyral (PVB) of 0.76 mm in thickness. Such a glazing, when it shatters, is likely to remain in place in the window opening; nonetheless, the slivers of glass, which retain their adhesion to the PVB, constitute a source of laceration, in particular at the level of the faces of the occupants.

The thrusting in of the glazing toward the passenger compartment deriving, in particular, sometimes from the bending of the components of the vehicle body or of the frame which contains the glazing constitutes, in this connection, quite understandably, a circumstance all the more aggravating when it occurs with formation of sections of the glazing into more acute angles penetrating into the passenger compartment. As a matter of fact, certain slivers of shattered glass located close to such relatively acute angles display sharp edges directed toward the occupants. Quite obviously, it is sought to minimize as much as possible the laceration affecting the faces of the occupants.

There are known, on the other hand, numerous burglarproof and/or bulletproof and/or shatterproof glazings, comprising at least three sheets of glass bound by various intercalations such as PVB, polyurethane (PU) of thicknesses in excess of 0.76 mm.

In the context of the use of a glass-adhesive-glass laminate as a side automobile glazing cited previously, patent application EP 0 418 123 A1 describes the improvement of the acoustical abatement properties, obtained through use of an appropriate intercalation of 0,8 to 2.0 mm in thickness. This intercalation is a vinyl chloride-glycidyl methacrylate copolymer; certain thermoplastic PU also may be suitable, PVB, on the contrary, being avoided.

Patent application EP 0 816 064 A1 relates to the lightening of the same type of glazing with retention of satisfactory mechanical properties, particularly in deflective strength. The use of thin sheets of glass, with thicknesses approximately equal to 0.5 mm, is made possible by the utilization of special, relatively hard intercalations, having a Young's modulus at least equal to 20 MPa, such as an ionomer resin, certain polyurethanes, certain polyesters, poly(ethylene terephtalate), certain acrylic resins.

In an unexpected manner, the inventors became aware that the increase in the thickness of the intercalary adhesive has the effect of reducing the extent of the laceration

phenomenon, in particular in the circumstances previously cited.

Consequently, the invention has as its subject the use of a laminated glazing composed essentially of two sheets of glass bound by means of an intercalary adhesive layer with a thickness in excess of 0.76 mm as an anti-laceration glazing, in particular for automobiles and transport vehicles.

In conformity with the invention, the anti-laceration property is evaluated on mannequins in accordance with tests described in the publication "Pickard J., Brereton P., Hewson A.: An objective method of assessing laceration damage to simulated facial tissues - The Triplex Laceration Index - Proceeding of 17th Conference - American Association of Automotive Medicine 1973 - Pages 148-165." This publication defines a laceration measurement scale between 0 and approximately 13 in practice, or even higher, observed on a vinyl mannequin head covered with two gauged leathers. The more numerous and deep the scratches, tearing and other damage to the two leathers and to the vinyl at the conclusion of the test, the higher the parameter obtained, called TLI (for Triplex Laceration Index).

In addition, there has been observed, as a secondary benefit obtained through the invention, an anti-laceration effect with respect to the air bags installed in the passenger compartment. This effect is manifested by a reduction in the bursting of air bags during accidents and, finally, by a better efficacy in their functioning.

According to a preferred variant of the invention, the glazing is used as an anti-laceration glazing in the non-intact state or, in other words, as a glazing affording anti-laceration properties with respect to an occupant or a mannequin striking against it when it already is shattered. It is easily understood that the laceration is far more severe under these conditions than when the occupant strikes against an intact glazing surface which breaks up only afterwards.

A second variant of the invention, preferred over the preceding one, corresponds to still more exacting conditions for measurement of the anti-laceration property. It concerns the use of a laminated glazing described above as a glazing having anti-laceration properties in the non-intact, bent state. This variant relates in particular to the case of glazings mounted, in the context of experimentation, in a frame articulated along at least one axis; in the case of impact originating from the exterior of the vehicle, a frame of this type sustains an angular deformation up to a minimal predetermined angle, scarcely less than 180°, bringing about the thrusting in of the glazing over a short distance into the passenger compartment.

Along the axis of articulation, the glazing has a U-shaped rounded top or a V-shaped edge, as the case may be. When the glazing is shattered, the more their edges are directed with a certain angle incident on the occupants, the more dangerous the fragments of glass located near the axis of articulation.

By "anti-laceration glazing" in the sense of the invention there is designated a glazing with appreciably improved anti-laceration properties in comparison with those of a conventional laminate, in particular a side automobile glazing the TLI of which, measured under extremely rigorous circumstances, such as on a non-intact, bent glazing, does not exceed 7, and particularly preferably, 6.

The thickness of the adhesive intercalary layer advantageously does not exceed 2 mm, or indeed 1.90 mm or even 1.53 mm. As a matter of fact, the increase in this thickness to higher values does not obtain a significant improvement in the anti-laceration effect, but results principally in a weighing down and a rise in price of the glazing.

Any plastic customarily used as an adhesive between two sheets of glass may be adopted for forming the intercalation, its being understood that the total thickness of the intercalary layer is in excess of 0.76 mm. Well suited for this purpose are

polyvinylbutyral, polyurethane, in particular thermoplastic polyurethane, RIM polyurethane, polycarbonate, poly(methyl methacrylate), polypropylene, ethylene/vinyl acetate copolymer, cycloolefinic copolymer, polyethylene, in particular in the form of an ionomer resin such as a (meth)acrylic acid and ethylene copolymer, neutralized with a polyamine, thermoplastic polyester, in particular poly(ethylene terephtalate), heat-hardening unsaturated polyester, acrylic resin possibly modified, vinyl chloride/glycidyl methacrylate copolymer. The intercalary adhesive layer may be formed of a single layer based on one of these plastics, combined with the customary additives, in particular plasticizers in variable proportions. Standard PVB, as well as the "acoustical" grade thereof, are entirely suitable, as are other compositions having excellent acoustical abatement properties, such as described in application EP 0 418 123 A1. According to an alternative, the intercalary adhesive layer is composed of a stack with a thickness in excess of 0.76 mm of several layers such as have just been defined. Stacks having acoustical abatement properties composed, for example, of one layer of PVB or other material appropriate for this invention and one layer of an acoustical resin separated by a barrier film of poly(ethylene terephtalate), as described in the patent application EP 0 763 420 A1, the content of which is incorporated herein by way of reference, are particularly suitable.

Each of the two sheets of glass of the glazing advantageously has a thickness ranging between 0.1 and 3 mm, in particular at least equal to 1.5 mm, and possesses a core compressive stress in the central zone ranging between 1 and 50 MPa, advantageously at least equal to 20 MPa. The glass used is float glass, more or less tempered; that is, from the fully tempered to merely annealed state and, preferably, semi-tempered.

According to a preferred embodiment, the invention also relates to the use of a laminated glazing comprising at least one functional layer. This may consist of one of the layers or sheets described above, obtained through the incorporation of the sought

function into this layer or this sheet, the composition of which is selected in a manner suited to this purpose. It also may relate to a more or less thin layer or a film intercalated between a sheet of glass and the intercalary adhesive layer or between two layers forming this intercalary adhesive, or even a functional layer or film directly in contact with the surrounding air, whether that of the outdoors or that of the passenger compartment.

A functional layer may consist of a hydrophobic/oleophobic layer, grafted in the form of a thin layer with a thickness ranging between 2 and 50 nm on the outer surface of a sheet of glass, or self-supported on a plastic film such as a poly(vinyl fluoride) (PVF) or poly(vinylidene fluoride) (PDVF) applied on the outer surface of the sheet of glass.

The functional layer also comprises a decorative and/or concealing layer, covering all or a portion of the surface of the laminated glazing.

This layer, for example, may replace the serigraphed decoration frequently deposited on the periphery of the inner face of glazings, in particular for automotive vehicles, for the purpose of concealing, for an observer located outside the vehicle, the vehicle-body elements forming the frame of the window opening and the line of glue which thus is protected from deterioration through ultraviolet radiation. It may comprise opaque or transparent colored decorative elements, making it possible to achieve tinted elements matching the vehicle body or the interior outfitting, logos, etc.

As other examples of functional layers, there may be cited optically selective layers, composed of stacks of layers which are distinguished by a high transmission in the visible spectrum (wavelengths of 400 to 800 nm) and a high absorption and/or reflection in the ultraviolet (< 400 nm) and infrared (> 800 nm) spectrum. These layers may consist of thin metal layers, for example silver-based, with thicknesses ranging between 2 and 35 nm, separated between themselves as well as from other adjacent layers or films by dielectric layers of indium, tin, silicon, zinc, titanium, tungsten, tantalum, niobium, aluminum,

zirconium, etc. oxides or nitrides, with thicknesses generally ranging between 10 and 150 nm. These layers may comprise at least one tinted layer in the whole.

The entirety of these layers may be a conductor of electricity; it may belong to the family of antisolar stacks, used to limit the conveyance of heat through solar radiation into closed spaces, or to that of low-emissive stacks used, on the contrary, to limit the loss of heat in closed spaces, due principally to a transmission of infrared radiation through the glazing. Such stacks are described in the patents FR 2 708 926 and EP 0 678 484.

The functional layers are formed in known manner through application of liquid precursors, according to conventional techniques of flow-coating, dipping, liquid spraying or curtain, by pyrolysis or by evaporation according to techniques such as CVD (Chemical Vapor Deposition), plasma, possibly under vacuum. The decorative and concealing layer or layers is/are provided on support films, in particular made of plastic, according to techniques used in printing: serigraphy, flexography, ink jet, laser printing.

The formation of optically selective stacks makes use of successive depositions by cathodic spraying, in particular aided by a magnetic field or the like. In this connection, reference again is made to the patents FR 2 708 926 and EP 0 678 484.

The formation of functional layers is achieved possibly with application of a heating and/or a radiation, in particular ultraviolet, according to polymerization, sol-gel, crosslinking, etc. processes.

According to a particularly advantageous embodiment, the laminated glazing comprises a plastic sheet on at least one of its outer faces. It very particularly concerns a sheet having anti-laceration properties and, possibly, self-repairing properties arranged on the glazing face directed toward the passenger compartment of the vehicle or the interior of the building. Such a plastic sheet comprises, for example, a layer of thermoplastic polyurethane used for adhesion with respect to the sheet of glass, and a layer of heat-

hardening polyurethane on the outside; that is, in direct contact with the atmosphere of the passenger compartment or the building interior; it is described in patent FR-2 398 606, incorporated herein by way of reference, and improves the anti-laceration properties of the glazing.

Use according to the invention is directed very particularly toward automobile glazing and, preferably, any side automobile glazing which is fixed or movable, for example vertically. A use as a windshield and rear window may be considered as constituting part of this invention by analogy, although the technical problems which it resolves and, in particular, the definition of the TLI below, relate exclusively to side automobile glazings; in the same way, a use as glazing for a building likewise is within the scope of the invention.

The noteworthy effect of the increase in thickness of the intercalation on the anti-laceration properties now is illustrated by the following examples.

EXAMPLE 1

The TLI (Triplex Laceration Index), as defined above, is measured on side automobile glazings composed of two sheets of float glass 2.1 mm in thickness, sandwiching a PVB intercalation of variable thickness. One of the glass sheets is merely annealed; that is, it has not been subjected to any tempering; the other has been partially tempered, to a degree corresponding to a surface stress of 45 ± 10 MPa, which is equivalent to a core compressive stress in the central zone approximately equal to 22 ± 5 MPa.

The measurement is made on a mannequin which strikes against the broken glazing mounted in an articulated frame having sustained an angular deformation corresponding to a thrusting in of the glazing 75 mm into the passenger compartment at the level of the axis of articulation.

The glazing has a length of 600 mm and a width of 450 mm.

The TLI measured is recorded in the following table for each thickness of PVB and type of glass used.

Thickness of PVB	Partially tempered glass	Annealed glass
0.38 mm	7.8	7.4
	6.9	9.7
	7.4	11.2
0.76 mm	5.8	6.9
	5.1	5.5
	5.7	7.4
1.14 mm	6.0	8.1
	5.2	7.2
	5.7	5.5
1.52 mm	4.5	4.7
	4.8	5.2
	4.9	5.7

For each type of glass, a linear interpolation of the TLI measurements in terms of the PVB thickness is performed and shown on the sole figure to which reference is made. The effect of improvement in the anti-laceration properties, in the case of broken, bent glazing, obtained through an increase in the thickness of the intercalary PVB, is clearly visible.

Under the same conditions, the TLI was measured on three side automobile glazings composed of two sheets of float glass 1.1 mm in thickness, slightly hardened, that is, having been subjected to a mild tempering, adhering to one another by means of an intercalation 2 mm in thickness. An acrylic acid and ethylene copolymer neutralized with a polyamine is selected as an intercalation. The TLI obtained are 3.8; 3.9; 4.1, corresponding to a noteworthy level of anti-laceration properties.